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Northern Cook Inlet Chinook  
and Coho Salmon Enhancement

by  
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F-27-R

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and Coho Salmon Enhancement

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ABSTRACT

In northern Cook Inlet, enhancement efforts for chinook salmon, *Oncorhynchus tshawytscha*, are contributing to the sport fishery harvest at the Deshka River and Sheep, Montana, and Willow Creeks. Preliminary results indicate a better survival rate for smolts released on 10 June than those released 10 days later with the same average size, and also better than of smolts released on 13 June of larger size. Information from this year's return will be incorporated after tag decoding and the year-class that will return next season.

Hatchery-produced coho salmon, *Oncorhynchus kisutch*, constituted at least 38% of the sport catch in the Little Susitna River in 1987. Preliminary results in 1988 indicate a 50% contribution. Analysis of marked fish from the creel census and egg take in 1987 indicate greater contribution from release of smolts than that of fingerlings.

In the Big Lake drainage, coho salmon released as pre-smolts and smolts had a higher percent of survival from time of release to smolting than did those released as fingerlings. The overall hatchery contribution to the smolt migration was 44%.

KEY WORDS: Salmon enhancement, northern Cook Inlet, chinook salmon, *Oncorhynchus tshawytscha*, egg take, coho

salmon, *Oncorhynchus kisutch*, release to smolting survivals, hatchery contribution.

## INTRODUCTION

Alaska's sport fishing population is a highly mobile group; the majority of them live in the Anchorage and Matanuska-Susitna River Valley areas. Correspondingly, the most intensely fished areas of the state are those within a 2-hour drive from the major population centers; i.e., the Kenai Peninsula waters and Knik Arm and Susitna River tributaries that are accessible from the Parks Highway. In northern Cook Inlet, the most important chinook salmon, *Oncorhynchus tshawytscha*, fisheries occur in Willow Creek and the Little Susitna River, while the most important coho salmon, *Oncorhynchus kisutch*, fisheries occur on tributaries to the Knik Arm, including: (1) the Little Susitna River, which is second only to the Kenai River in angler-hours fished, (2) the Cottonwood Creek drainage, (3) the Big Lake drainage, and (4) tributaries to the Susitna River (Willow, Little Willow, Caswell, and Sheep Creeks).

While the number of commercial fishermen remains fairly static because of limited-entry laws, the sport-fishing effort has continued to increase with the increase in population, necessitating a species prioritization for hatchery-produced salmon. Sockeye salmon, *Oncorhynchus nerka*, pink salmon, *Oncorhynchus gorbuscha*, and chum salmon, *Oncorhynchus keta*, have been targeted for commercial use, and the less abundant chinook and coho salmon have been targeted for sport fishermen.

Sport-fishing effort in the Cook Inlet area has been increasing dramatically (Mills 1986). As the fishing pressure on Kenai Peninsula drainages has increased, there has been some shift in effort to the less-crowded northern Cook Inlet river systems.

Two new access projects greatly enhanced the opportunity for sport fishermen to get closer to the prime fishing areas. One, at the mouth of Willow Creek, is nearly complete but remained walk-in for the 1988 season, while the Deshka Landing location has copious parking area and a usable boat ramp. Completion of boat-launching facilities at the mouth of Willow Creek is anticipated before next season.

With the additional access, a significant increase in sport-fishing effort is expected on the lower east and west side Susitna River and Yentna River tributaries. This increased effort will not necessarily mean more restrictive fishing regulations, however, because supplemental chinook salmon production through smolt-stocking projects in Willow, Sheep, and Montana Creeks should provide additional fish for harvest and escapement. This year, for example, because adequate escapement was achieved and significant numbers of chinook salmon were present in lower Willow Creek, the sport fishery was extended for an additional three-day weekend. With even greater numbers of chinook salmon anticipated next season in Willow Creek, rather than extending the fishery an extra weekend to harvest "colored-up" fish, the first weekend fishery will be changed to a seven-day fishery with the following three weekends being three-day fisheries. Until additional supplemental returns are established in other eastside Susitna River tributaries, it is likely that during three-day weekends, only sport fisheries will continue in those streams.

Supplemental production of chinook and coho salmon by the Fisheries Rehabilitation, Enhancement and Development (FRED) Division of the Alaska Department of Fish and Game (ADF&G) is becoming an important tool for providing additional sport-fishing opportunities in northern Cook Inlet. Big Lake and Fort Richardson Hatcheries currently serve in augmenting the fishery by producing chinook and coho salmon fingerlings and smolts (Clevenger 1986; Wall 1987). Fingerlings, which are released in

underutilized lakes connected to anadromous streams, take advantage of existing food supplies for juvenile development.

The strategy of releasing smolts takes advantage of their ability to readily imprint to the release location, but, because of their migratory nature, competition for food between introduced smolts and other juvenile salmonids is minimal. The adults from the fingerling and smolt releases will increase the number of fish available for sport fishermen, return to their respective imprinting sites, make the collection of brood fish more efficient, and allow for determination of the most efficient release strategy.

The chinook salmon enhancement program in northern Cook Inlet consists of waters draining into Cook Inlet via the Susitna River and Knik Arm (Figure 1). Enhancement efforts for chinook salmon are directed toward road system-accessible waters. Road-accessible tributaries containing potential chinook salmon broodstock are Willow, Sheep, and Montana Creeks (eastside Susitna River tributaries), and the Little Susitna River (Cook Inlet tributary via Knik Arm). Currently, the Willow Creek stock is being developed as the brood for Willow, Sheep, and Montana Creeks, while the Little Susitna River broodstock will be developed for the Little Susitna only. There is no foreseeable program utilizing remote stocks at this time.

The coho salmon enhancement program in the northern Cook Inlet area consists of watersheds that drain into Knik Arm: (1) the Big Lake watershed that drains via Fish Creek; (2) the Cottonwood Lake watershed that drains via Cottonwood Creek; (3) the Little Susitna River that heads in Nancy Lake and the Talkeetna Mountains; (4) Wasilla and Spring Creeks that drain via Rabbit Slough; and (5) the Jim Creek (Figure 1).

All five species of Pacific salmon return to the Big Lake watershed (approximately 176,486 hectares). Sockeye and coho

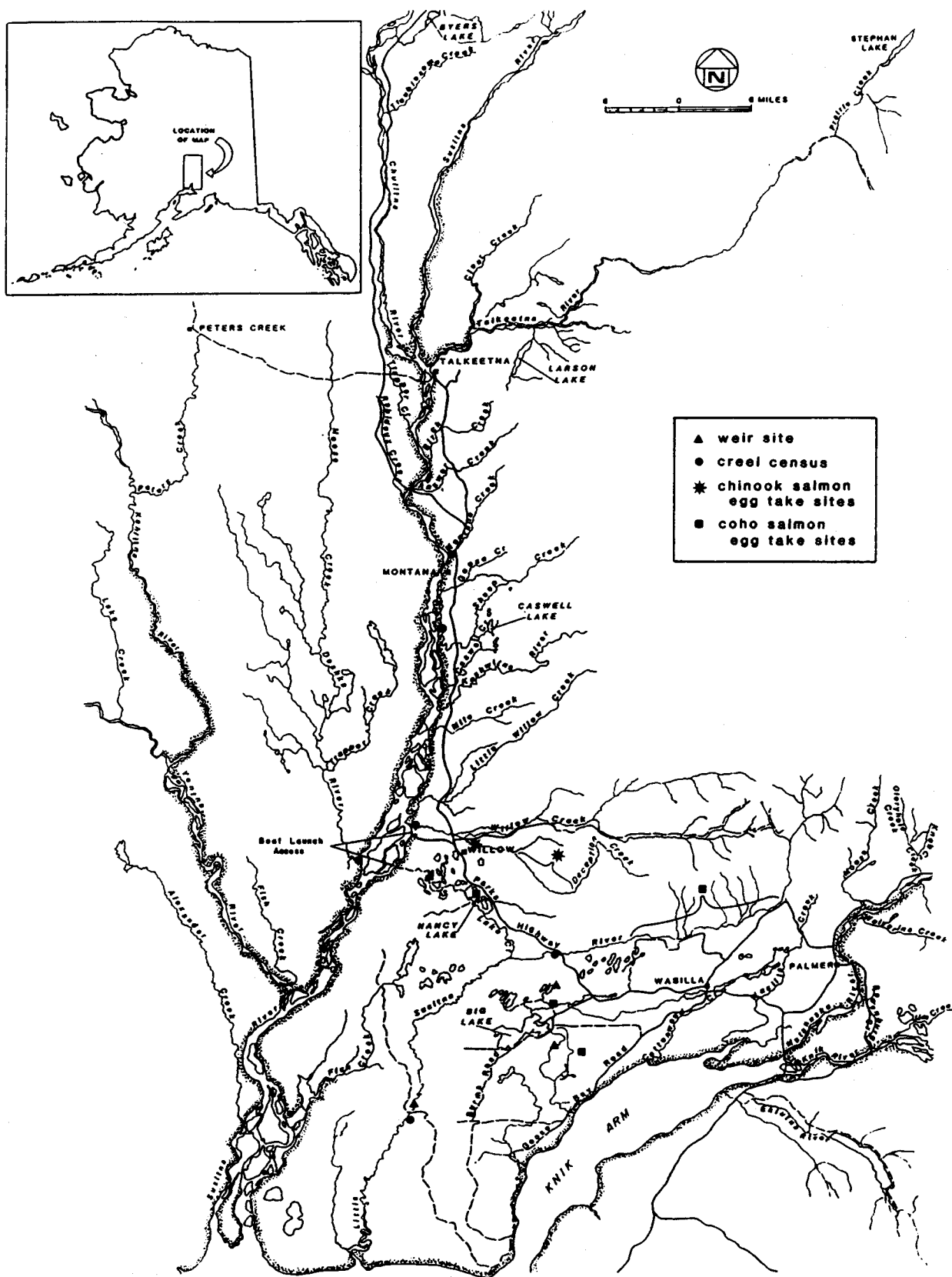


Figure 1. Northern Cook Inlet drainages, creel-census locations, weir sites, and egg-take sites.

salmon are the dominant species, while chinook, pink, and chum salmon have only minor representation. Escapements have been monitored since 1936. Commercial fishing for Big Lake sockeye and coho salmon occurs in Cook Inlet with drift and set nets. To protect coho salmon escapement, commercial fishing is prohibited after 29 July; however, prior to that time, if an escapement of 50,000 sockeye salmon is projected, both commercial and personal-use fisheries at the mouth of Fish Creek may be opened by emergency order. Curtailment of recreational fishing for coho salmon prior to mid-August usually ensures that half of the coho salmon run escapes potential harvest in an intertidal sport fishery. Depending on run strength, this catch normally ranges from 150 to 500 fish.

The Cottonwood Creek watershed (approximately 331 hectares) consists of numerous interconnected lakes that drain through Wasilla Lake and into Cottonwood Creek (See Figure 1). Although all five species of Pacific salmon use the system, coho and sockeye salmon are predominant. During the 1970s, the ADF&G, Sport Fish Division's annual index-area counts indicate the presence of only a few hundred sockeye and coho salmon spawners. Since then, the number of people in the Matanuska-Susitna Valleys has increased, access has become easier, numerous subdivisions have been built, and many road-related culverts have been placed within this system. Sport fishing for sockeye salmon is prohibited, but during mid-August through September, weekend openings allow fishing for coho salmon in the lower 6 km of Cottonwood Creek.

The Little Susitna River (approximately 72 km in length) supports a coho salmon run that has exceeded 35,000 fish (sport catch plus escapement) in recent years. No special freshwater management strategies have been required to ensure escapement.

The Wasilla Creek, Spring Creek, and Rabbit Slough area is highly accessible from the Glenn and Parks Highways. During recent

years, fishing effort has exceeded 10,000 angler-days. Because of run size and angling effort, this area is a weekend-only fishery from mid-August through September. Other accessible streams may receive this much effort each year with fisheries that are open continuously.

Jim Creek drains into Knik River, which empties into Knik Arm and is accessible via logging roads from the "old" Glenn Highway. Fishing is permitted seven days a week and effort regularly exceeds 9,000 angler-days, annually.

## OBJECTIVES

### Chinook Salmon Enhancement and Biological Studies

1. Operate a weir on Deception Creek (tributary to Willow Creek) to monitor escapement, collect broodstock, take eggs, and identify marked fish.
2. Recover coded-wire-tagged (CWT) fish during creel census, carcass surveys, and egg take to estimate survival rates of treatment lots and their relative contribution rates.
3. Take approximately 800,000 eggs for incubation at Fort Richardson Hatchery and release age-0 smolts into Willow, Sheep, and Montana Creeks in 1989.

### Coho Salmon Enhancement and Biological Studies

1. Evaluate the hatchery contribution to the smolt stage of fingerlings, pre-smolts, and smolts stocked in the Big Lake drainage. Determine the amount and proportion of hatchery-produced fish in the smolt and adult life stages by recovery of CWT fish during the migrations and the egg take.

2. Determine the amount and proportion of hatchery-produced fish from smolt and fingerling releases in the Little Susitna River drainage that contribute to the adult return by recovery of CWT fish during weir escapement counts, creel censuses, egg takes, and carcass surveys.
3. Take approximately 500,000 eggs from the Little Susitna River for incubation at Fort Richardson Hatchery for release as age-1.0 smolts in Nancy Lake.
4. Take approximately 1,000,000 eggs from the Little Susitna River for incubation at Big Lake Hatchery for release as fry into tributary lakes of the Little Susitna River.
5. Take approximately 1,000,000 eggs from Fish Creek and Meadow Creek (Big Lake drainage) for incubation at Big Lake Hatchery for release as fry into the Big Lake and Cottonwood Creek drainages and as smolts into the Big Lake drainage, Wasilla and Jim Creeks.
6. Count coho salmon escapement at the Fish Creek weir and recover marked fish from Fish Creek.

#### MATERIALS AND METHODS

##### Chinook Salmon

##### Adult Studies:

Marked adult chinook salmon were recovered at the Deception Creek weir and at Sport Fish Division creel-census locations (See Figure 1.) Each marked fish was handled according to sampling instructions provided by the ADF&G CWT Recovery Laboratory (1986)

and forwarded to the lab for tag extraction, decoding, and identification.

Fish caught at the weir provided mark-recapture data, information about run timing and escapement, as well as samples to determine average sizes and ages. In addition, fish were collected for egg takes.

The Deception Creek weir, located at the mouth of Deception Creek (a tributary to Willow Creek), was operational from 6 through 25 July. The weir at Deception Creek and another weir on the Little Susitna River were designed specifically for those locations. The weir was oriented so that fish would be directed into a holding box located in the main channel where the fish could be handled.

The Deception Creek weir was constructed of 1.8-m-long x 1.3-cm-diameter conduit inserted through holes 2.54 cm apart in 3.04-m-long, 5-cm x 5-cm x 4.7-mm aluminum angle. Weir sections were supported by tripods constructed from 2-m-long x 6.35-cm-diameter aluminum conduit. A live box was also constructed from aluminum angle and conduit materials; its dimensions were 2.45-m-long x 1.22-m-wide x 0.91-m-high. The floor and lids were of marine plywood painted light yellow.

The creel census for chinook salmon was operated by Sport Fish Division personnel at the confluences of Willow, Sheep, and Montana Creeks and the Deshka and Susitna Rivers (Hepler 1988). Proportional contribution estimates and variances were computed using Vincent-Lang (unpublished report) according to the formula:

$$\hat{P}_S = m_C / \sum n_C$$

where:

$\hat{P}_S$  = the proportional contribution of the enhanced stock,

$m_C$  = the number of marks from the enhanced stock observed in the fishery,

$\phi$  = the proportion of the enhanced stock marked at the time of release, and

$n_C$  = the number of examined fish.

The variance of  $\hat{P}_S$  is:

$$V(\hat{P}_S) = m_C / \{ [n_C(n_C-1)\phi^2] \} * [1 - (m_C/n_C)].$$

#### Egg Takes:

The Fish Culture Manual (ADF&G 1983) outlines the basic procedures for collection and spawning of fish; however, the actual collection techniques for brood fish varies both between and within the drainages. Except at the Deception Creek weir, the egg-take sites in northern Cook Inlet are remote (See Figure 1). Collection of fish was done by hauling one floating, stretched gill net downstream toward a second barrier gill net. The gill nets consisted of #15 green nylon monofilament and 9.1-m-long x 1.8-m-deep with 76-mm-square mesh netting. A vertical line at each end was tied to the float line, webbing, and lead line. The "poly" float line had a 38-mm diameter, eye loops were located on all four corners of the net, and 76- by 127-mm floats were spaced at 380-mm intervals. The single, lead-core line weighed 0.7 kg/m; lead and vertical lines were tied every 152 mm.

On site, green eggs were fertilized, rinsed, poured into a 37.8-liter container filled with water for water hardening. Ice was immediately added to gradually reduce the water temperature to about 5°C; eggs were never added to precooled water. Within 2-3 hours, the water temperature in the transport container was about 5.5°C. Immediately prior to transport, more ice was added to containers for the 2- to 3-hour transport because ambient air temperatures varied between 14°C and 15°C. The overall concept was to slow egg development so that the "tender-handling" period

that follows water hardening was not reached while the eggs were in transport or before they were seeded into the incubator. Water-hardened eggs were transported to Fort Richardson Hatchery by pick-up truck and the egg containers were fastened down and riding on 15 cm-20 cm of foam cushioning. Upon arrival at Fort Richardson Hatchery, the water temperatures in the egg containers ranged between 4°C and 5.5°C.

### Coho Salmon

#### Juvenile Studies:

Coho salmon eggs were incubated at the Fort Richardson and Big Lake Hatcheries. After hatching and rearing, fish were planted into selected locations as fingerlings, pre-smolts, and smolts. To evaluate their survival to smolt and adult life stages, fish at both facilities were marked with CWTs. Marking procedures were conducted in accordance with the procedures described by Moberly et al. (1977). The number of fish to mark and recover was determined by the FRED Division biometrics staff. The mark-recovery plan was designed for either the smolt or adult life stage and numbers of fish to mark varied greatly depending upon whether tag recovery was at either the smolt or adult life stage.

Juvenile salmon emigrating from Big Lake were captured daily during May and June with a modified fyke net mounted on a weir equipped with a manually operated subsampler and collection box. The funnel-shaped weir used to collect smolts was constructed of 1.8-m-long x 1.3-cm-diameter conduit inserted into a 5-cm x 5-cm x 4.7-mm aluminum angle that was 3.04-m-long with holes 2.54-cm apart. Weir sections were placed at an obtuse angle against the current, supported by 2-m x 6.35-cm aluminum conduit tripods. Lateral wings measuring 7.6-m-long by 1.2-m-high were attached to either end of the weir to facilitate directing fish toward the end of the funnel. The throat of the modified fyke net was located at the apex of the funnel and it led into the subsampler.

The subsampler had two holding boxes; the entrance to either one was controlled by a door that directed the current through the desired entrance.

The evaluation schedule was designed to sample the entire day's migration of the smolts. Particular emphasis was placed on determining the proportion of hatchery-produced fish in the respective populations.

At Fish Creek, a tributary to Knik Arm of northern Cook Inlet and the outlet of Big Lake, smolts were hand-counted during the entire 24-hour "day" (0000 to 2400 hours); however, when the number of smolts was too much to count, a biomass-sampling technique was used. Determination of when to use the biomass-sampling technique was made by on-site personnel while the migration was occurring.

When the biomass-sampling technique was employed, the total weight (kg) of all smolts was measured and a subsample of these fish was weighed and counted to determine the average number of smolts per kg. Each tared net full of fish was suspended by a three-sided frame from a hanging 20-kg- by 50-g-capacity dial scale.

Approximately 80-100 smolts were removed from the sampler box and weighed. Depending on the migration strength, 3 to 5 of ten net-fulls of fish (i.e., subsamples) were both weighed and counted to determine the average number of smolts per kg. As the smolts were counted, the species representation was also determined. Estimates of the total number of smolts were calculated daily according to the formula:

$$N = \frac{(Tw) (n)}{(SW + Hc)}$$

where:

N = estimated total number of emigrating smolts,  
 Tw = total weight (kg) of smolts captured,  
 n = average number of smolts in subsample count,  
 Sw = average subsample weight (kg), and  
 Hc = hand count of non-subsampled smolts.

Daily estimates were summed to estimate the total annual emigration. Fish that were hand counted and those in weighed subsample counts were anesthetized in a solution of 2.3-g MS-222<sup>®</sup> and 3.0-g NaHCO<sub>3</sub> in 45.5 liters of water and examined for marks. In addition, lengths (mm) and weights (g) from 20 fish per day were recorded and seven scales from the "preferred area" of each smolt were collected and mounted. All fish with clipped fins were measured and weighed and scale samples were taken. Scales were placed on 7.62-cm x 2.54-cm microslides and covered by another slide. The slides were secured at each end with labeling tape. Corresponding information from the data log was also recorded on each slide of scales. All smolts were placed into a holding box immediately after they were enumerated where they recovered from the anesthetic before being released.

A minimum of 150 marked smolts was sought for collection for tag recovery. Information from decoded tags was used to evaluate scale characteristics respective of fingerling, pre-smolt, and smolt-release lots. These characteristics were applied to identify the release lots from scales of smolts. The proportion of hatchery-produced smolts was estimated based on the formula:

$$\hat{P}_S = m_e / \phi n_C$$

where:

$\hat{P}_S$  = the proportion of hatchery-produced smolts,  
 $m_e$  = the number of marked smolts observed,

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$\phi$  = the proportion of hatchery-produced smolts marked at the time of release, and  
 $n_C$  = the number of fish examined.

The variance of  $\hat{P}_S$  is:

$$V(\hat{P}_S) = m_e / \{ [n_C(n_C-1)\phi^2] * [1-(m_C/n_C)] \}.$$

Scale characteristics and ages of smolts were determined from scales by using a microfiche reader. Age designations were recorded according to the European formula.

#### Adult Studies:

Eggs from coho salmon were incubated at Big Lake and Fort Richardson Hatcheries. After hatching and rearing to the fingerling stage at Big Lake Hatchery, or the smolt stage at Fort Richardson Hatchery, the juvenile fish were transported to selected locations. To evaluate their survival to the adult stage, some fish from both facilities were marked by excising the adipose fin and inserting a CWT into the fish's snout. Marking procedures were conducted in accordance with the procedures described by Moberly et al. (1977). The number of fish to mark and the required number to recover were determined by FRED Division biometrics staff.

CWT fish were recovered at weirs, at Sport Fish Division creel-census sites, or at egg-take locations. Heads or snouts from marked fish were forwarded to the FRED Division CWT Recovery Laboratory for tag extraction and decoding to determine release-lot identification.

Fish caught at weirs provided mark-recapture data, information about escapement timing, and collection of size data and scales. In addition, some weirs were used to collect broodstock for egg takes.

A weir for adult coho salmon located approximately 1.6 km downstream from the outlet of Big Lake in Fish Creek was fished from early July through 27 August. An in-water viewing device was used to examine the fish for the presence or absence of the adipose fin. This method employed a glass-bottomed box partially immersed below the stream water surface. The device was located in the opening of the weir where the fish would briefly pause before proceeding into the holding box and allowing the observer to look down from above to determine if the adipose fin was present. A dull, yellow-surfaced plate was placed on the substrate to increase the contrast between the background, and the subject did not appear to impede the natural upstream movement of the fish. (Other colors, such as shades of green, shades of blue, black, and silver had previously been tested and rejected.) A sliding gate at the exit of the holding box could be closed by the observer to detain fish to collect scales and size data. Hatchery personnel operated the weir at Big Lake Hatchery on Meadow Creek, which is upstream from Big Lake, to collect coho salmon broodstock. The operation and design of the Meadow Creek weir has been described by Clevenger (1986).

On the Little Susitna River, Sport Fish Division personnel operated a weir to count the escapement of several species and a creel census at Houston, the Burma Road, and the Ship Creek (Anchorage) boat landing to recover CWTs from marked fish. Estimation of hatchery contribution to the creel was determined by Bartlett and Conrad (1988). Estimation of hatchery contribution from each release lot to the egg take was done by collecting heads from spawned marked fish, recording numbers of fish killed and observed, interrogating the tags, and calculating the preparation of hatchery-produced fish with the same methods described for adult chinook salmon.

## RESULTS

### Chinook Salmon

#### Adult Studies:

Chinook salmon eggs have been taken from fish in selected drainages of northern Cook Inlet since 1983 (Table 1). Since 1986 studies of returning adults have been conducted to assess the results of releases.

Chinook salmon smolts were first released into Deception Creek (a tributary to Willow Creek) in 1985: of 534,389 released, 30,275 fish were marked. Within the release lots, there were three different treatments: two nearly equal-sized lots of fish that were released at the same size (14.0 g) but with a 10-day separation in time of release (10 June and 20 June). The third lot with about half as many fish as either of the other lots, was released on 13 June; however, the smolts were 4.0-g heavier and were full-term-reared smolts. Marked chinook salmon from the 1985 release have been recovered from Deception Creek in 1986 as ages 0.1 and 1.1, in 1987 as ages 0.2 and 1.2, and in 1988 as age 0.3 and 1.3. Of the 121 "jack" chinook salmon examined in 1986, five were marked; one was age 1.1 and the remainder were age 0.1. Approximately 72% of the "jack" population in Deception Creek in 1986 was of hatchery origin. In 1987, 692 age-0.2 and -1.2 fish were examined for marks. Twenty-eight were observed, but heads from only 14 marked fish could be collected. Of those, 12 tags were decoded. In 1988, 6 heads from marked fish were collected from 265 fish that were examined from the escapement, and 12 heads were recovered during the creel census.

The proportional contributions in the 1986 year-class of the age-1.1 and -0.1 "jacks" from the 1985 release was estimated at 0.037 (standard error = 0.00139) and 0.647 (standard error = 0.10211),

Table 1. Fort Richardson Hatchery chinook and coho salmon production for northern Cook Inlet.

Fish released									
-----									
	Brood	Eggs incubated					Total	Number	Dominant
		-----							
Species	year	Origin	Number	Year	Location	Lifestage	number	marked	return
									year
Chinook	1983	Willow Creek	307,000	1985	Willow Creek	smolt	101,256	8,152	1989
Coho	1983	Little Susitna R.	56,000	1985	Little Susitna R.	smolt	54,000	12,000	1986
Chinook	1984	Willow Creek	759,000	1985	Willow Creek	smolt	433,133	22,123	1989
Coho	1984	Little Susitna R.	594,000	1986	Little Susitna R.	smolt	474,106	23,217	1987
Chinook	1985	Willow Creek	377,000	1986	Willow Creek	smolt	325,304	28,188	1990
Coho	1985	Little Susitna R.	552,000	1987	Little Susitna R.	smolt	247,843	20,187	1988
Coho	1985	Caswell Creek	60,000	1987	Caswell Creek		31,767	0	1988
Coho	1986	Little Susitna R.	549,700	1988	Little Susitna R.	smolt	421,388	24,628	1989
Chinook	1987	Willow Creek	574,300	1988	Willow Creek	smolt	180,155	20,936	1992
				1988	Montana Creek	smolt	110,850	21,615	1992
				1988	Sheep Creek	smolt	132,125	0	1992
Chinook	1988	Willow Creek	800,000 <sup>a/</sup>						

a/ Preliminary estimate

respectively. In the 1987 year-class, among age-1.2 and -0.2 "2-ocean" fish, the estimated proportional contributions from the release lots was 0.033 (standard error =  $5.4 \times 10^{-4}$ ) for age-1.2 fish, 0.166 (standard error =  $4.55 \times 10^{-3}$ ), age-0.1 fish released on 20 June, and 0.417 (standard error =  $1.06 \times 10^{-2}$ ) for age-0.1 fish released on 10 June. Heads from marked fish that were also collected in 1988 have been sent to the FRED Division CWT Recovery Laboratory and results will be available in early winter.

#### Egg Takes:

The double weir on Deception Creek was fished from 5 through 25 July. When the maturity of the fish was checked on 19 July, approximately 350 fish were being held and several fish appeared ready to spawn. On 20 July eggs were stripped from 59 females, fertilized, and transported to Fort Richardson Hatchery, and another egg take was scheduled for 25 July. Unfortunately, a two-day, non-stop rain ensued. The rain did not cause a flash flood but it did bring high enough water to completely cover and dislodge the weir, and the fish were able to swim over the top. The remainder of the eggs were eventually obtained over a five-day period by collecting fish from the spawning grounds upstream of the weir.

#### Coho Salmon

##### Juvenile Studies:

Coho salmon have been planted in selected drainages of northern Cook Inlet since 1976 (Tables 1 and 2). During 1988 studies to estimate the coho salmon smolt population in the Big Lake drainage commenced 9 May and ended 30 June. An estimated 124,724 coho salmon smolts migrated through the Fish Creek weir. Of 51,296 fish observed, 780 had excised adipose fins; of these, scales from 416 were collected to aid in identification and

Table 2. Big Lake Hatchery coho salmon production, 1977-1988.

Brood year	Eggs incubated		Fry released					Dominant return year
	Drainage	Number	Year	Location	Size(g)	Number	Number marked	
1976	Big Lake	79,983	1977	Big Lake	0.28	40,673	23,852	1980
1977	Big Lake	589,623	1978	Big Lake	0.70	101,081	40,959	1981
1977	Big Lake		1978	Cottonwood Lake	0.80	317,694	32,064	1981
1978	Big Lake	842,238	1979	Big Lake	0.49	383,295	20,218	1982
			1979	Cottonwood Lake	0.54	246,762	19,992	1982
1979	Big Lake	927,708	1980	Big Lake	0.64	99,736	0	1983
			1980	Big Lake	0.38	351,151	22,337	1983
			1980	Cottonwood Lake	0.63	154,991	15,000	1983
			1980	Cottonwood Lake	0.49	155,004	15,000	1983
1980	Big Lake	543,081	1981	Big Lake	0.46	118,071	13,072	1984
			1981	Cottonwood Lake	0.78	179,117	18,450	1984
			1981	Cottonwood Lake	0.45	181,658	18,500	1984
1981	Big Lake	1,242,993	1982	Big Lake	0.41	585,548	23,085	1985
			1982	Cottonwood Lake	0.45	364,911	86,850	1985
1981	Little Susitna	3,113	1982	Little Susitna	0.40	2,950	0	1985
1982	Big Lake	2,782,857	1983	Big Lake	0.45	1,612,337	21,607	1986
1982	Cottonwood Lake	232,332	1983	Cottonwood Lake	0.45	368,022	21,917	1986
1982	Little Susitna	500,775	1983	Little Susitna	0.57	216,508	20,835	1986
1983	Big Lake	1,664,295	1984	Big Lake	0.76	986,552	10,000	1987
1983	Cottonwood Lake	25,796	1984	Cottonwood Lake	0.91	372,318	10,000	1987
1983	Little Susitna	547,214	1984	Little Susitna	0.91	426,216	10,000	1987
1984	Big Lake	3,082,000	1985	Big Lake	0.30	1,053,000	10,000	1988
	Cottonwood Lake	35,000	1985	Cottonwood Lake	0.30	336,000	10,000	1988
	Little Susitna	1,350,000	1985	Little Susitna	0.30	1,225,000	10,000	1988
1985	Big Lake	2,620,000	1986	Big Lake	1.0	2,355,000	15,000	1989
	Cottonwood Lake	0	1986	Cottonwood Lake	1.0	316,000	10,000	1989
	Little Susitna	364,000	1986	Little Susitna	1.0	316,270	0	1989
1986	Big Lake	2,900,000	1987	Big Lake	1.2	1,775,934	15,600	1990
	Little Susitna	15,000	1987	Cottonwood	1.4	315,916	0	1990
			1987	Big Lake	7.3	500,000	20,000	1989
1987	Big Lake	3,000,000	1988	Big Lake	1.2	2,047,000	14,050	1991
			1988	Big Lake	17.0	20,400	20,400	1989
			1988	Wasilla Creek	17.0	6,575	0	1989
			1988	Jim Creek	17.0	7,550	0	1989
			1988	Rabbit Slough	17.0	6,275	0	1989
			1988	Little Susitna a/	1.0	3,374,126	3,126	1991

a/ Aerial stocking into drainage lakes: My, Yohn, Hock, Delyndia, Butterfly, West Papoose, East Papoose.  
Vehicle stocking of; Horseshoe, Finger, and Nancy Lakes.

determination of numbers of smolts attributable to the fingerling, pre-smolt, or smolt-release lots. Heads were collected from 160 of the marked fish for tag decoding. Marked fish represented four release lots: (1) 1986 fingerling release of 2.7 million with 15,000 marked fish; (2) 1987 fingerling release of 1.2 million with 16,800 marked fish; (3) 1987 late-September pre-smolt release of 0.455 million with 20,000 marked fish; and (4) a 1988 early-May smolt release of 20,000 fish, all of which were marked. By reading scales from tagged fish from known release lots, discernable differences in scale patterns were noted. Scales of fish from the 1986 fingerling release had a pattern similar to those of wild fish. Also, those from the 1987 fingerling release were similar to those of the 1986 fingerling release except they had one freshwater check instead of two. Scales from the pre-smolts and smolts were also somewhat similar. Scales from smolts had circuli deposited tightly around the focus with gradual spreading out farther away and had a check on the perimeter of the scale, whereas pre-smolt scales exhibited the same close, evenly distributed circuli beginning around the focus to approximately mid-scale (possibly the time shortly after release occurred) where the circuli along an imaginary line anterior from the focus exhibited a disturbed deposition pattern. The areas adjacent to this imaginary line, however, exhibited normal circuli deposition. Origins of the release lots were then assigned for the 416 scales collected from marked fish and the hatchery contributions were estimated.

The proportional contribution by hatchery-produced fish from the 1986-1987 fingerling releases, 1987 pre-smolt, and 1988 smolt releases was as follows: 0.194 (standard error =  $6.8 \times 10^{-4}$ ), 0.143 (standard error =  $2.0 \times 10^{-4}$ ), 0.096 (standard error =  $4.1 \times 10^{-5}$ ), and 0.008 (standard error =  $1.15 \times 10^{-9}$ ), respectively. Consequently, the hatchery contribution in 1988 from stocking was 0.91% of the fingerlings that had been released in 1986, or 24,168 fish; 1.50% of the fingerlings released in 1987, or 17,888 fish; 2.80% of the 1987 pre-smolts released in

late-1987, or 12,005 fish; and 4.79% of the smolts released, or 958 fish. The overall hatchery contribution was 55,019 fish, or 44.1% of the 124,724 smolts that emigrated.

#### Adult Studies:

Adult fish studies were implemented from 1980 through 1988 to assess the results of these releases. For 1988, however, only early, in-season mark-recovery results were available. Mark recovery for the 1988 return will be completed by mid-October 1988 and reported in its entirety in the fiscal year 1989 annual report.

There was an escapement of 3,871 coho salmon into the Big Lake drainage (Fish Creek) from 9 July to 27 August 1987. Of these, 1,500 were examined for excised adipose fins, and heads from nine marked fish were collected. Three had no tag, four were from the 1984 release and returned as age 2.1, and the other two were from the 1985 release and returned as age 1.1. Although this sample size is small, the estimated proportion of hatchery contribution of age-2.1 fish was 0.416 (standard error =  $4.33 \times 10^{-2}$ ), and of age-1.1 fish, it was 0.146 (standard error =  $1.07 \times 10^{-2}$ ). The estimated hatchery contribution was 56% or 2,168 fish.

In the Little Susitna River drainage, two release lots consisting of smolts and fingerlings contributed to the 1987 return. At the egg-take site, based on results from marked fish with tags from a sample of 1,646 fish, the estimated proportions that resulted from the smolt and fingerling releases was 0.524 (standard error =  $6.3 \times 10^{-3}$ ) and 0.155 (standard error =  $4.17 \times 10^{-3}$ ), respectively. Stocking numbers were similar (497,323 smolts and 436,216 fingerlings), but an estimated 863 adults were from the smolt release and 256 were from the fingerling release--about 3.4 times as many smolts than fingerlings.

## Egg Takes:

In 1987 an estimated 206,000 coho salmon eggs were collected from Caswell Creek and transported to Fort Richardson Hatchery. The estimated 150,000 smolts produced will be released in June 1989 into selected locations within the Caswell Creek drainage.

An estimated 525,000 eggs from Little Susitna River coho salmon were collected and transported to Fort Richardson Hatchery for incubation and rearing. The estimated 300,000 smolts that result will be released in June 1989 in the Little Susitna River drainage. Most of these will be released at a broodstock development location to maintain and improve future egg takes.

In the Big Lake drainage, coho salmon egg-take goals were met with an egg take of an estimated 3 million eggs. Resulting fish will be released as fingerlings, pre-smolts, and smolts in selected Knik Arm tributaries.

## DISCUSSION

FRED Division efforts in the northern Cook Inlet area are designed to augment existing chinook and coho salmon runs. This program has followed the sequence of efforts according to the fish species and drainage prioritization presented in the ADF&G plan for supplemental production in Cook Inlet (ADF&G 1981). Assessment of hatchery returns of adult chinook and coho salmon in northern Cook Inlet depends on coordination of a variety of information collection systems, including several Sport Fish Division creel-census projects and FRED Division escapement weirs and egg takes. With the careful coordination and intense efforts of personnel from both the Sport Fish and FRED Divisions, these programs are becoming successful in rehabilitating salmon runs and increasing sport fishermen harvests.

## Chinook Salmon

### Adult Studies:

At Willow Creek, hatchery-produced smolts released in 1985 have returned as adults in 1986, 1987, and 1988. The average year-class composition of the Willow Creek chinook salmon stock has been as follows: age 1.2, 15%; age 1.3, 21%; and age 1.4, 64%. Typically, age-1.1 "jacks" have rarely been observed, either because sport fishermen are not required to log their catch or because they are released. Results of scale reading (Chlupach 1987) of chinook salmon caught at the Deception Creek weir in 1986 indicated the following age composition: age 0.1 and 1.1, 7%; age 1.2, 15%; age 1.3, 26%; and age 1.4, 52%. Conversely, because sport fishermen select for "3- and 4-ocean" fish, it appears that an accurate age structure may only be achieved by combining results from the creel census and the escapement.

With current age-class composition of chinook salmon in Willow Creek, the greatest contribution for the first release will be in 1989. In the 1988 return, hatchery-produced fish returned as "2-ocean" fish from the 1986 stocking and as "3-ocean" fish from the 1985 stocking. Creel-census crews collected 13 heads from marked fish and the egg-take crew collected another 6 heads. With three different release lots in 1985 to help determine optimal release time and size, the recovered tags are invaluable. Many more tagged fish will be available in 1989. Thus far, however, results indicate that the earliest release timing (10 June) of 14-g smolts had stronger survival and representation in the return than the same-sized smolts released on 20 June. The 18-g smolts released on 13 June had even less representation.

Preliminary creel-census analysis (Hepler 1988) shows that the estimated hatchery contribution to the creel in Willow Creek in 1988 was 20%. It is apparent that the hatchery-produced fish made a significant contribution because Willow Creek was the only

drainage in northern Cook Inlet to have its sport fishery extended for an additional three-day weekend. During that time, however, fish were beginning to mature and their flesh quality was generally less desirable. In 1989 the fishery will be regulated so that fishermen will have a better chance of harvesting "bright" fish (Larry Engel<sup>1</sup>, pers. comm.). The new regulations will allow more fishing time during the first week of fishing with a 7-day opening followed by three, 3-day weekend openings instead of the usual four, 3-day "weekends-only."

In 1988 marked fish that had been stocked at Willow Creek were also caught at the mouth of the Deshka River and Montana Creek. This indicates that hatchery-produced fish are contributing to the creel at other anticipated locations as well.

To spread out effort and catch in the future, hatchery-produced smolts from Willow Creek brood were also stocked in Montana and Sheep Creeks in 1988. This stocking strategy will be continued annually. Most fish from the first release will return in 1991 and 1992, but "1-ocean" fish will begin to return in 1989.

#### Egg Take:

The egg-take goal of 800,000 chinook salmon eggs from Willow Creek was reached, but only with difficulty. However, because of annual difficulties, e.g., with abrupt water-level changes, the weir design for Deception Creek will undergo further modification prior to the 1989 season.

#### Coho Salmon

The most popular sport fisheries for coho salmon on road-system streams in northern Cook Inlet are the Knik Arm tributaries of

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<sup>1</sup> ADF&G, Sport Fish Division, Palmer, Alaska.

Jim Creek, Rabbit Slough, Cottonwood Creek, Fish Creek, and the Little Susitna River. Of these, only Jim Creek and the Little Susitna River are open seven days each week. The Little Susitna River is the most intensive of all the Knik Arm coho salmon fisheries.

Coho salmon enhancement projects in northern Cook Inlet are presently targeted for the Little Susitna River, Cottonwood Creek, Big Lake (Fish Creek), Jim Creek, and Wasilla Creek-Rabbit Slough, all of which drain into the Knik Arm, and Caswell Creek, which drains into the Susitna River. The Fish Creek coho salmon broodstock is continuing to be developed as the donor stock for Knik Arm tributaries, with the exception of the Little Susitna River where the Little Susitna River stock is used. Along the Parks Highway, the Caswell Creek project also employs the indigenous coho salmon broodstock.

Present supplemental programs that utilize fingerling stocking occur in the Big Lake, Cottonwood Lake, and Little Susitna River drainages. The pre-smolt stocking program is currently limited to Big Lake, and smolts are stocked in Big Lake, Little Susitna River, Rabbit Slough-Wasilla Creek, and Jim Creek. The evaluation phase of the program ultimately will help to identify the most efficient stocking strategy to achieve the greatest number of adults. Much of the evaluation program is concentrated in the Big Lake drainage where both smolt and adult weirs are used to evaluate the survival rates and contribution of fish stocked at each of the three life stages.

#### Juvenile Studies:

During 1988 an estimated 124,724 coho salmon smolts migrated from Big Lake. Of these, an estimated 44% were of hatchery origin: 19.4% originated from the 1986 fingerling release, 14.3% from the 1987 fingerling release, 9.6% from the 1987 pre-smolt release, and 0.8% from the 1988 smolt release. It should be noted that

there was an apparent 44% tag-loss rate among the marked fish. These marked fish without tags most likely originated from the 1986 and 1987 fingerling releases because very few marked smolts that had been released as fingerlings were caught during the latter part of the migration; however, they constituted the majority of marked fish early in the migration. In addition, the scale pattern of the marked smolts that had no tags resembled those of smolts that had been released as fingerlings. Taking that into consideration, the survival rates from the 1986 and 1987 fingerling releases to the smolt emigration in 1988 would be 2.1% and 1.3%, respectively.

Because a large number of coho salmon fingerlings are released into Big Lake, greater numbers of smolts are contributed by the fingerling releases than from the pre-smolt or smolt releases, even though these have a lower survival rate from time of release to emigration as smolt. Fyke netting in the Big Lake drainage after the smolt migration yielded several large marked and unmarked juvenile coho salmon. These fish are expected to emigrate as smolts next year; however, they may not emigrate at all. In any event, coho salmon released as smolts and pre-smolts contributed a greater number of smolts per number of fish stocked than did the fingerlings released.

#### Adult Studies:

Annual escapement of coho salmon into the Big Lake drainage appears to fluctuate greatly (Table 3); however, some of the fluctuation apparently is an artifact of the duration of annual enumeration and methods. Similarly, it appears that run sizes during the 1970s have been smaller than during earlier years; however, since that time, data were rarely collected later than early August.

From 1980 through 1987 weir operations began in early July and usually extended into early September. In 1980 and 1981 the weir

Table 3. Coho salmon escapement into Fish Creek, Big Lake watershed, 1936 through 1987.

Year	Dates	Methods	Total number coho salmon	5-year mean
1936	7/15-8/11	Weir		
1937	7/21-8/09	Weir	489	
1938	7/10-8/08	Weir	19,417	
1939	7/11-8/12	Weir	2,764	
1940	7/04-8/12	Weir	16,546	
1941	7/04-8/09	Weir	9,720	9,787
1942-1948	No actual counts conducted			
1949	7/09-8/17	Weir	1,642	
1950	7/09-8/17	Weir	1,042	
1951	7/04-8/16	Weir	1,953	
1952	7/12-8/09	Weir	277	
1953	7/11-8/05	Weir	71	
1954	7/13-8/09	Weir	1,057	
1955	7/08-8/08	Weir	4,417	
1956	7/08-7/31	Weir	22	1,169
1957	7/12-8/25	Weir	15,630	
1958	7/04-7/28	Weir	592	
1959	7/10-8/02	Counting Screen		
1960	7/04-7/31	Counting Screen		
1961	7/04-7/31	Counting Screen		
1962	7/04-7/31	Counting Screen		
1963	7/04-8/01	Counting Screen	1,814	
1964	7/04-7/31	Counting Screen		
1965	7/04-8/08	Counting Screen	792	
1966	7/05-7/31	Counting Screen		
1967	7/03-7/31	Counting Screen	984	
1968	7/01-7/31	Counting Screen	2,088	
1969	7/04-9/02	Weir	4,253	
1970	7/04-8/08	Weir	1,048	
1971	7/03-8/07	Weir	583	1,791
1972	7/02-9/08	Weir	709	
1973	7/01-9/06	Weir	210	
1974	7/07-9/06	Weir	1,154	
1975	7/03-9/11	Weir	1,601	
1976	7/05-9/10	Weir	765	888
1977	7/05-8/15	Weir	970	
1978	7/03-9/30	Weir	3,121	
1979	7/05-8/30	Weir	3,000	
1980	7/04-9/01	Weir	8,832	
1981	7/09-9/07	Weir	2,261	3,637
1982	7/12-9/08	Weir	5,201	
1983	7/05-8/30	Weir	2,342	
1984	6/29-9/19	Weir	4,510	
1985	7/25-8/30	Weir	5,089	
1986	7/14-8/26	Weir	2,166	
1987	7/09-8/27	Weir	3,871	3,862

was located between the Knik Arm-Goose Bay Road and the inter-tidal area. Because of vandalism and harassment of personnel, the weir was moved in 1982 to a site approximately 14.5 km upstream (about 1.6 km from the Big Lake outlet). Escapement counts for the latter site indicate approximately 45% (range: 29%-64%) of the fish have passed the weir by the end of August (Appendix A; Chlupach 1987).

Since 1982 hatchery-produced fish have contributed to the escapement of coho salmon in the Big Lake drainage (Table 4). The contribution has ranged from an estimated 3% to 81%, with a total of about 23,519 fish, or an estimated average annual contribution of 3,359 fish per year. Thus far, this production has been solely from fingerling releases; however, in 1989 adults will also return from pre-smolt and smolt releases. In 1987, the estimated hatchery contribution was 56% of the 3,871 fish escapement.

Both coho salmon smolts and fingerlings have been released into Nancy Lake, which drains into the Little Susitna River. The fingerling release in 1984 was approximately 436,216 fish, while the smolt release in 1986 was about 497,323 fish. With this release strategy, adults from both release lots would return in the same year. At the egg-take location, based on tag recovery and interrogation, adults from fish released as fingerlings accounted for about 15% of the return, while those from fish released as smolts accounted for about 52% of the total return. All adult coho salmon at the egg-take site are of hatchery origin; however, the origin of 32% of these fish cannot be accurately assigned because of tag loss. Most of these fish, however, probably originated from fingerling releases because the loss rate for half-length CWTs is greater than for full-sized CWTs.

Results from the 1987 creel census to evaluate the harvest of coho salmon on the Little Susitna River (Bartlett and Conrad

Table 4. Estimated hatchery contribution of adult coho salmon in northern Cook Inlet, 1980 - 1987.

Drainage	Year	Dates of weir operation	Total escape	Percent thru weir at end	Number of Fish					Percent hatchery produced
					Examined	Marked	Hatchery produced	Range		
								Low	High	
Cottonwood Lake	1981	14 Jul -7 Sep	2,436	100	2,436	67	683	521	803	28
Cottonwood Lake	1982	20 Jul -6 Sep	2,064	37	764	11	376	348	386	18
Big Lake	1980	16 Jul -1 Sep	8,924	100	8,924	441	752	725	779	8
Big Lake	1981	9 Jul -7 Sep	2,382	100	2,382	72	178	165	191	7
Big Lake	1982	18 Jul -8 Sep	5,201	58	3,001	66	2,136	2,116	2,210	42
Big Lake	1983	15 Jul-31 Aug	2,342	44	1,037	8	365	346	384	16
Big Lake	1984	18 Jul-19 Sep	4,510	64	2,880	9	128	117	139	3
Big Lake	1985	25 Jul-30 Aug	5,089	29	1,499	15	1,289	1,253	1,325	25
Big Lake	1986	14 Jul-26 Aug	2,166	37	816	9	1,746	1,704	1,788	81
Big Lake	1987	9 Jul-27 Aug	3,871	28	1,500	9	2,168	2,156	2,180	56
Little Susitna R.	1986						367	302	432	3
Little Susitna R.	1987a/				1,646	42	863			52
						6	256			16
Little Susitna R.	1987b/		9,000				3,201			38
							454			3

a/ Results from egg take at brood return location

b/ Creel census results (Bartlett and Conrad, 1988)

1988) show that a minimum estimated 38% of the sport catch was from hatchery-produced fish. The creel census was designed to collect fish to evaluate hatchery contribution; unfortunately, fish were only examined for clipped adipose fins that represented smolt releases. Other adults were also present from hatchery-produced fish released as fingerlings. Preliminary creel-census information from 1988 indicates a sport harvest of 13,000 fish, of which an estimated 50% were hatchery-produced.

Over 100 heads from adipose fin-clipped fish have been collected thus far. With those expected from the egg take to be adequate, data should be available to help identify contribution from the fingerling and smolt releases.

In 1989 smolts from Fort Richardson Hatchery are scheduled for release in the Little Susitna River and Caswell Creek drainages. Production from Big Lake Hatchery will include releases for Big Lake and Cottonwood Lake drainages, Wasilla Creek, Rabbit Slough, Jim Creek, and the Little Susitna River.

## CONCLUSIONS

### Enhancement of Chinook and Coho Salmon Sport Fisheries

Sport fishing opportunities have been increased in northern Cook Inlet through supplemental production of chinook and coho salmon, as evidenced by the following facts:

1. An estimated 25% of the chinook salmon returning to Willow Creek were of hatchery origin in 1987. In 1988 preliminary estimation of contribution to the creel by hatchery-produced fish was 20%.
2. Coho salmon from hatchery-produced fingerlings released in the Big Lake drainage represent 40% of the escapement. Nearly half of all smolts were of hatchery origin.
3. The strategy of releasing coho salmon smolts at Nancy Lake (a tributary to the Little Susitna River) and fingerlings in other parts of the drainage is resulting in a significant contribution to the sport catch. In 1987 the harvest of hatchery-produced coho salmon comprised 38% of the catch. Preliminary results from the 1988 creel census indicate an estimated 50% contribution to the fishery.

### Chinook Salmon Biological Studies

1. The weir on Deception Creek (Willow Creek) operated successfully in 1988 until it was overtopped by a flood. It is being redesigned for 1989.
2. Preliminary results from recovered CWT fish suggest that the best release strategy is to release 14-g smolts on or about 10 June; however, additional studies are required before results are conclusive.

3. The 1988 chinook salmon egg take was successful despite the loss of the weir.

#### Coho Salmon Biological Studies

1. The 1987 coho salmon egg take successfully achieved the goals set for the Little Susitna River for both Fort Richardson and Big Lake Hatcheries, and for the Fish Creek and Meadow Creek for Big Lake Hatchery.
2. The Fish Creek smolt and adult weirs were operated successfully to enumerate and evaluate both smolt and adult migrations.

### RECOMMENDATIONS

#### Chinook Salmon

1. Continue to take chinook salmon eggs from Willow Creek for smolt releases into Willow, Sheep, and Montana Creeks.
2. Continue to mark a portion of the smolts released into Willow and Montana Creeks to assess their survival and contribution as adults to the sport fishery.
3. Continue operations to recover marked, adult chinook salmon at the Deception Creek weir and during creel census at Willow and Montana Creeks to assess the contribution of hatchery-produced adults to the escapement and sport fishery.
4. Utilize Fort Richardson Hatchery to incubate eggs and rear fingerlings to the smolt stage.

5. Begin a Little Susitna River chinook salmon enhancement project based on smolt releases.

#### Coho Salmon

1. Continue coho salmon egg takes from the Little Susitna River and Big Lake broodstocks to raise fingerlings for release from Big Lake Hatchery.
2. Continue coho salmon egg takes from the Little Susitna River and Caswell Lake broodstocks. Incubate and rear these to the smolt stage for release from Fort Richardson and Big Lake Hatcheries.
3. Continue CWTing a portion of the juvenile coho salmon prior to release from Fort Richardson and Big Lake Hatcheries.
4. Continue to evaluate comparative contributions to the smolt stage of coho salmon stocked as fingerlings, pre-smolts, and smolts in the Big Lake drainage.
5. Continue to evaluate comparative contribution from smolts and fingerlings released into the Little Susitna River in both the sport fishery and the egg-take broodstock.
6. Continue to produce 30,000 to 60,000 smolts and 400,000 pre-smolts annually at Big Lake Hatchery for release into Knik Arm tributaries.
7. Continue to develop new or improved fish collection and egg-transport techniques.

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APPENDIX



Appendix. Fish Creek daily and cumulative counts for coho salmon, 1987.

Date	Number of Jacks in Daily	Daily	Cumulative	Percent of Expanded Enumeration	Percent of Enumeration
JULY 9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	1	2	2	0	0
16	0	2	4	0	0
17	0	1	5	0	1
18	0	1	6	0	1
19	0	4	10	0	2
20	0	1	11	0	2
21	0	0	11	0	2
22	0	0	11	0	2
23	0	1	12	0	2
24	0	5	17	1	4
25	0	5	22	1	5
26	1	2	24	0	5
27	0	1	25	0	5
28	0	1	26	0	5
29	0	0	26	0	5
30	0	0	26	0	5
31	0	29	55	6	12
AUG 1	0	17	72	4	15
2	1	9	81	2	17
3	2	28	109	6	23
4	4	56	165	12	35
5	1	38	203	8	43
6	0	25	228	5	48
7	0	16	244	3	52
8	0	23	267	5	57
9	1	13	280	3	59
10	0	20	300	4	64
11	0	14	314	3	67
12	0	21	335	4	71
13	0	9	344	2	73
14	0	5	349	1	74
15	0	3	352	0	75
16	1	26	378	5	80
17	2	16	394	3	84
18	1	11	405	2	86
19	1	8	413	2	88
20	0	4	417	1	88
21	0	9	426	2	90
22	1	9	435	2	92
23	1	13	448	3	95
24	1	6	454	1	96
25	0	6	460	1	98
26	0	0	460	0	98
27	2	11	471	2	00
Totals			471 a/		

a/Fish Creek was walked and floated to Tyonek power line on 8/27/87.  
There were an additional 3,400 coho present, cumulative count adjusted to this addition.

